Beam shape at DØ

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- More results
- Comparison with Tevatron emittance from SDA
- Possible Z offset?
- Detailed beam shape
- Conclusions

For this talk, every time I said X I mean vertical…. Sorry about that.

Beam width measurement at DØ

The model we are using is very simple:

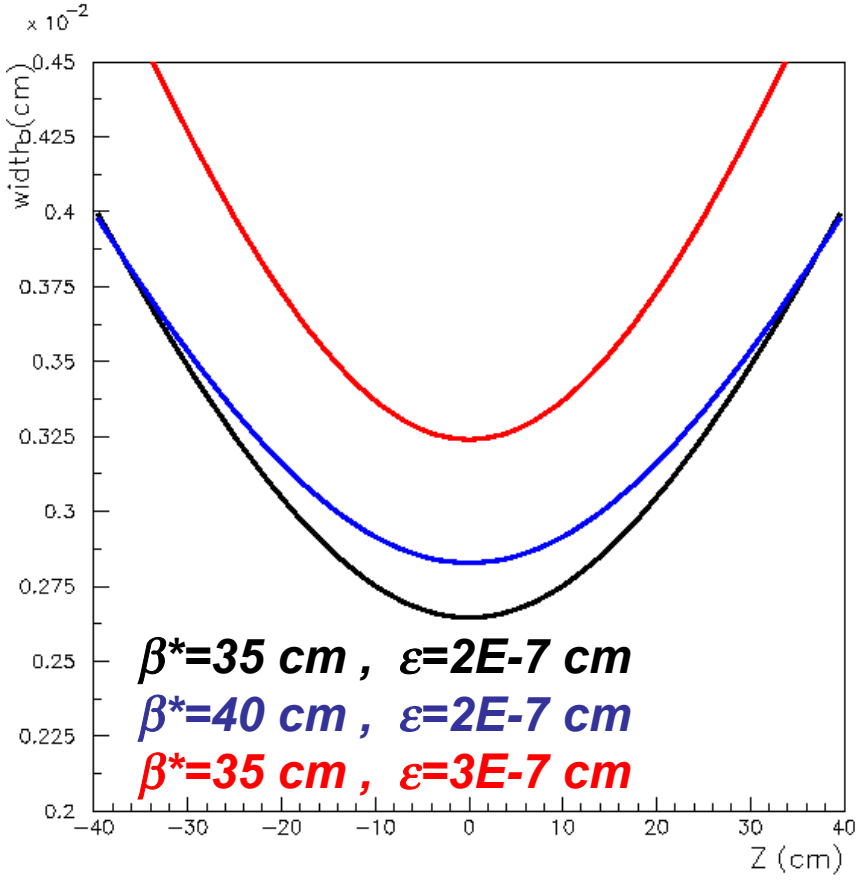
Two beams with no X-Y coupling, same “optic” for p and pbar.

The interaction region is a drift in the Tevatron, one expects.

$$\sigma^2 = \varepsilon_{eff}\left[\beta^* + \frac{(z - z_0)^2}{\beta^*}\right]$$

$$\varepsilon_{eff} = \frac{\varepsilon_p \varepsilon_{pbar}}{\varepsilon_p + \varepsilon_{pbar}}$$

In the beams division they expect ***β*=35 cm.***



measurement of the shape of the luminous region

vertex method

$$\sigma^2_{obs} = \sigma^2_{beam} + k \times \sigma^2_{vertex}$$

Uses:

•coordinates of the reconstructed vertexes

•estimated errors on this vertexes

Assumes:

•unbiased reconstructed vertex position

•error estimation proportional to the real error

pair of tracks method

$$d_i = y\cos(\varphi_i) - x\sin(\varphi_i)$$

$$\langle d_1 d_2 \rangle = \sigma^2_F \cos(\varphi_1 - \varphi_2)$$

Uses:

•track parameters

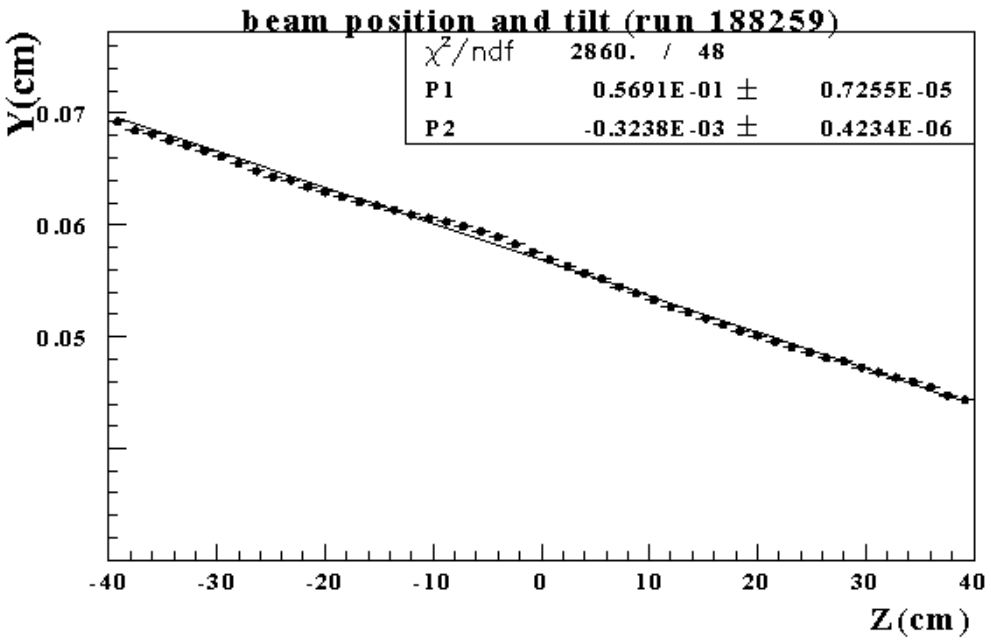
Assumes:

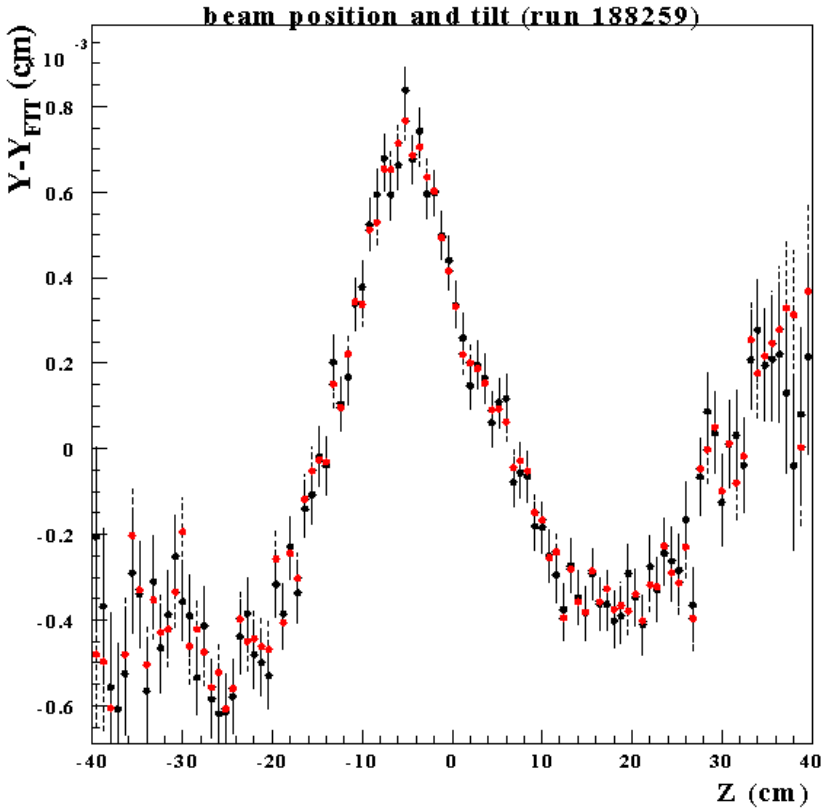
•unbiased track parameters

•uncorrelated errors in the track parameters

Here I assume circular beam, but in our calculation we do not make this assumption (formula a bit more complicated).

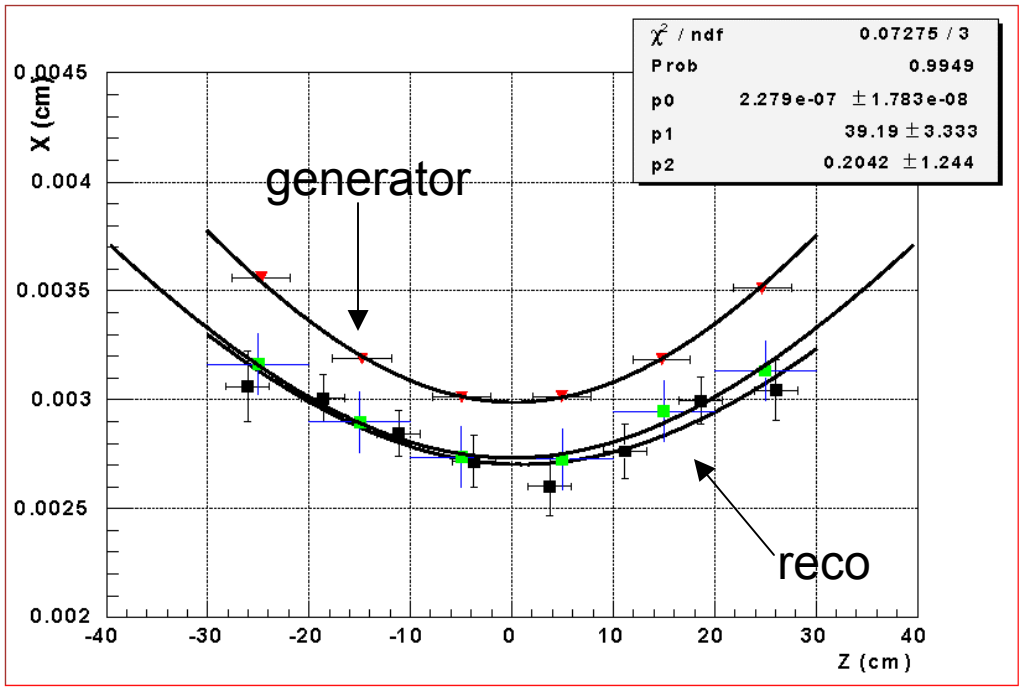
Beam position





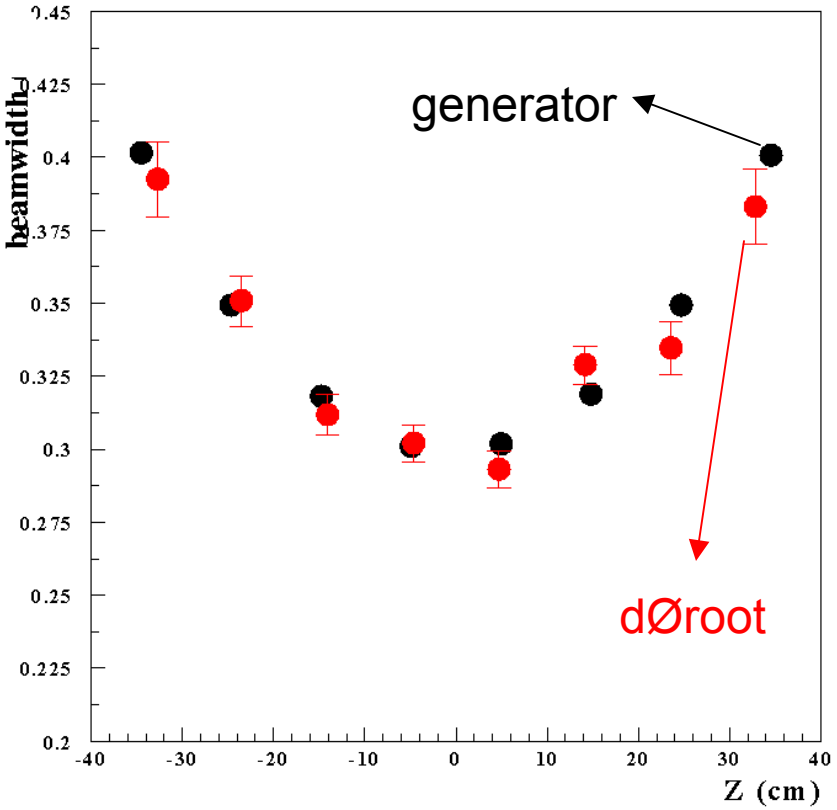
misalignment?

Calibration using MC



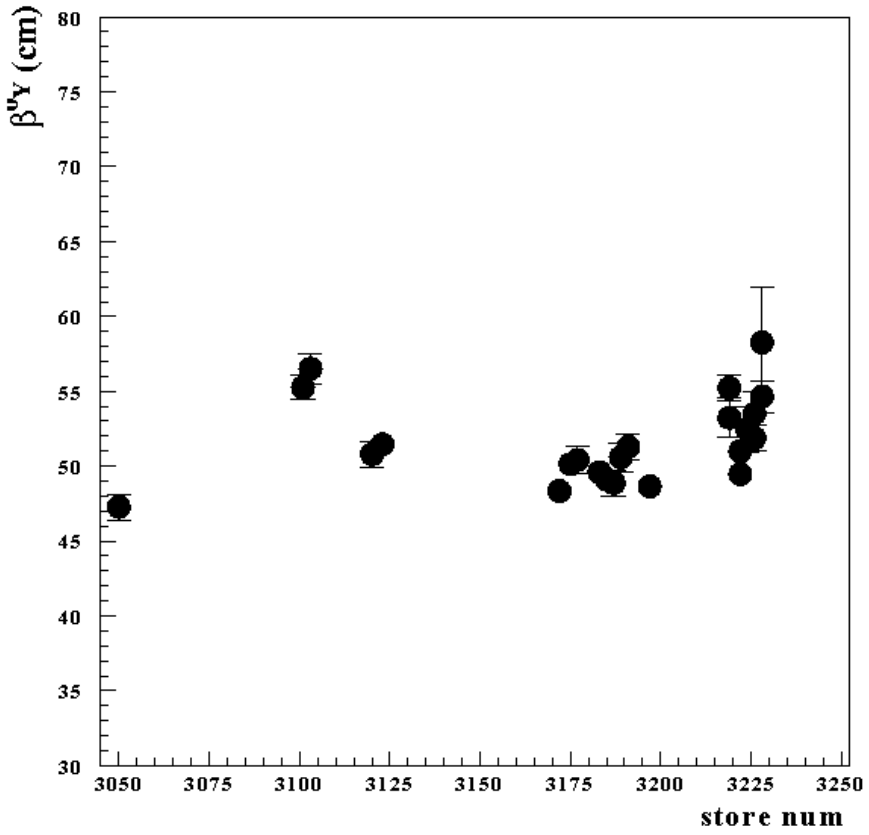
Using reco both method give us a 10% bias. For the vertex method this is solved with the re-vertexing done in dØroot.

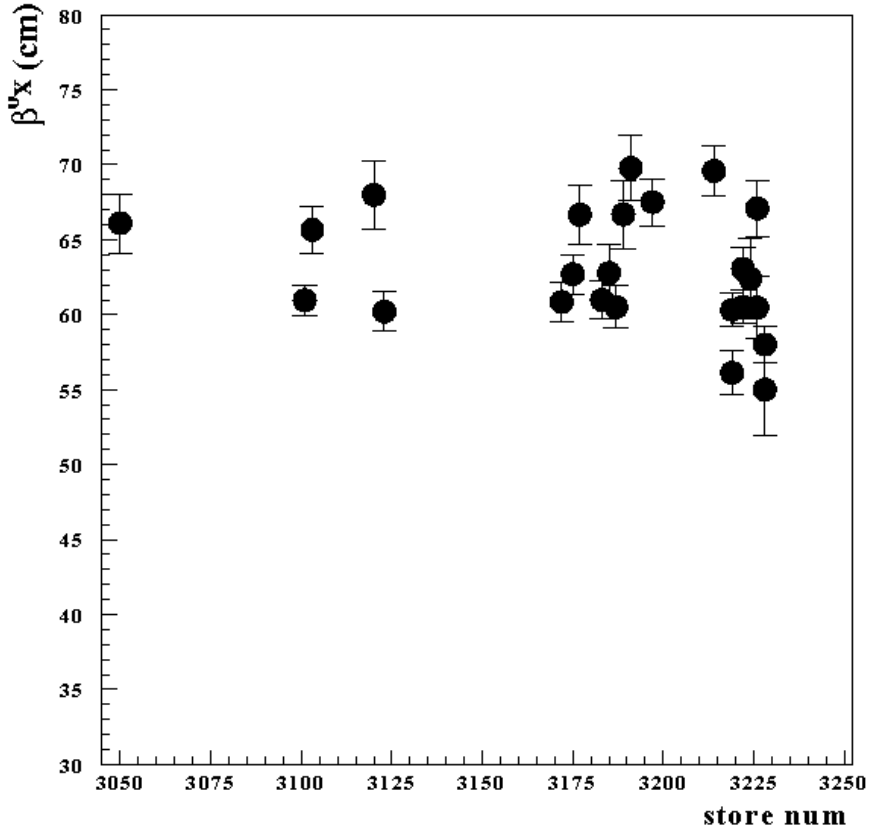
MC calibration



Using dØroot the bias goes away (in the vertex method). We can get the right shape from MC when we use dØroot.

More results





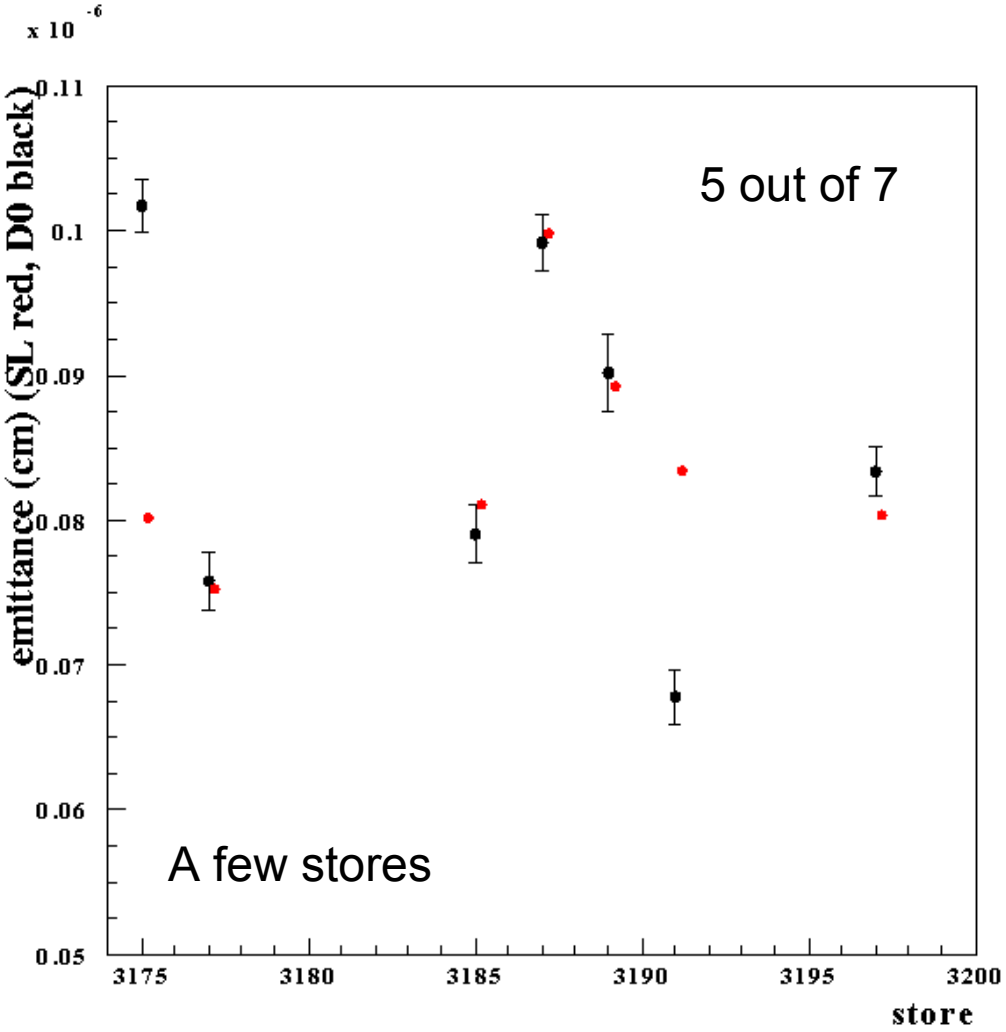
The new data confirms what we have been seen. The curvature of the beam shape in DØ is consistent with large β*. The plots show all the stores that we (Avdhesh) has analyzed. Thank Avdhesh Chandra for this work!!!!

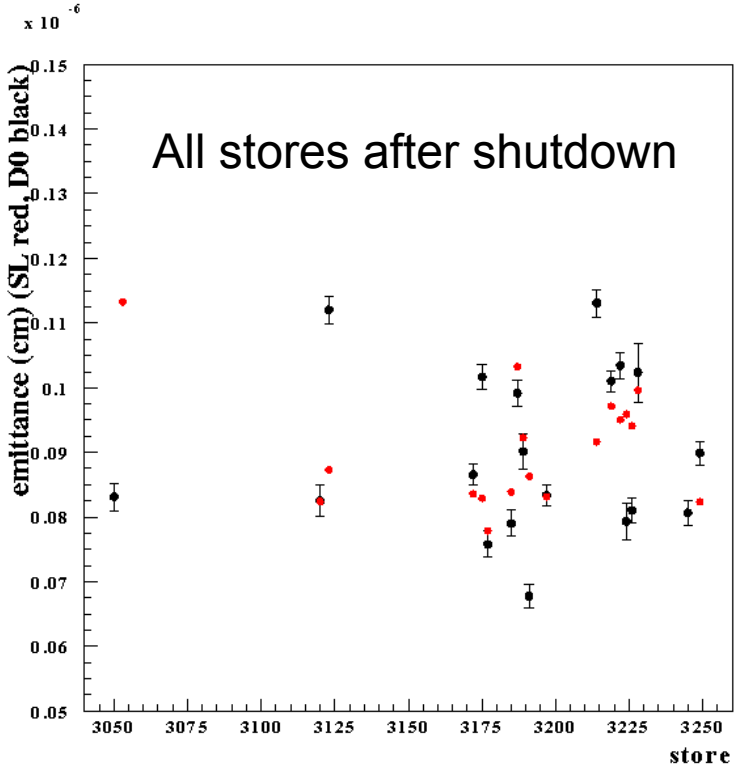
Emittance, NOT a trivial thing to measure at the Tevatron.

Shot summary 3224 02/08/2004 20:56:09 Initial Stack size: 149.388

Shot #3224	Proton Vertical pi-mm-mr	Proton Horizontal pi-mm-mr	Proton Longitudinal eV-sec	Pbar Vertical pi-mm-mr	Pbar Horizontal pi-mm-mr	Pbar Longitudinal eV-sec
Accumulator	.	.	.	3.33	8.371	0.847
MI 8 Gev	10.29	11.18	.	275.28	456.29	1.01
MI After Coalescing	.	.	.	.	.	.
MI 150Gev	13.11	14.02	.	10.98	7.60	2.44
Proton Injection	19.06	33.01	3.43	.	.	.
Pbar Injection Porch	17.95	34.28	3.33	.	.	.
Pbar Injection	17.75	34.05	3.31	9.74	24.76	3.47
Before Ramp	18.15	35.00	3.28	10.07	26.86	3.46
Flattop	20.83	20.87	3.79	10.89	13.11	4.02
Squeeze	20.78	24.14	3.72	12.71	13.54	3.74
Initiate Collisions	21.28	23.46	3.77	12.43	13.34	3.70
Remove Halo - FW [Sync lite]		24.37 [28.80]	3.80		10.84 [48.80]	4.05
begin of HEP - Sync Lite	29.19	29.24	.	34.39	46.92	.
end of HEP FW [Sync lite]	36.88 [49.04]	49.14 [62.84]	3.80	30.52 [51.70]	19.73 [53.56]	4.05
Effective Emittance	22.64(17.81)	22.64(17.81)	.	.	.	.
Initial Lumosity	53.157	CDF	.	48.682	DZero	.

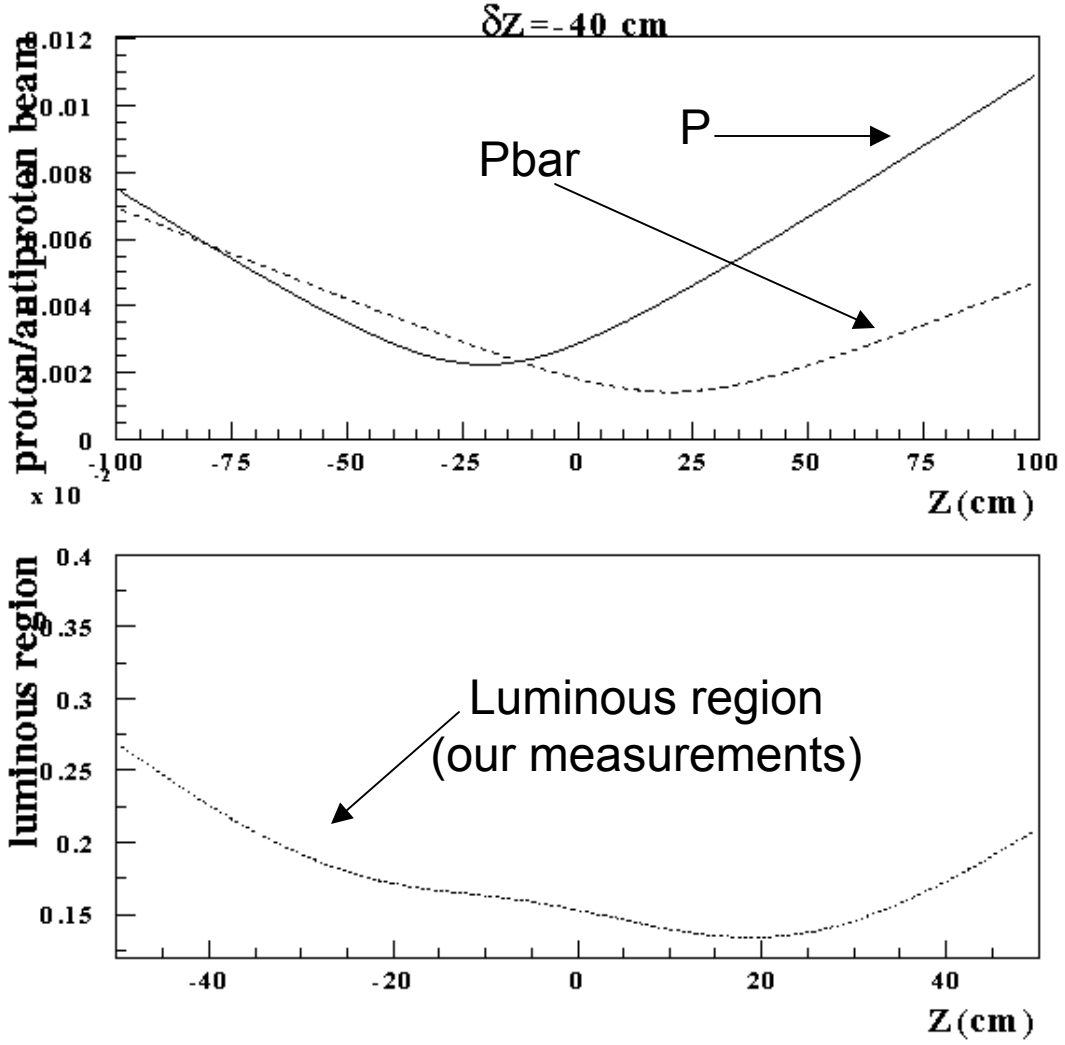
Emittance comparison





Multiplicative factor applied to the emittance from SDA to “match” the selected stores. There is some correlation….

Is this at all possible?



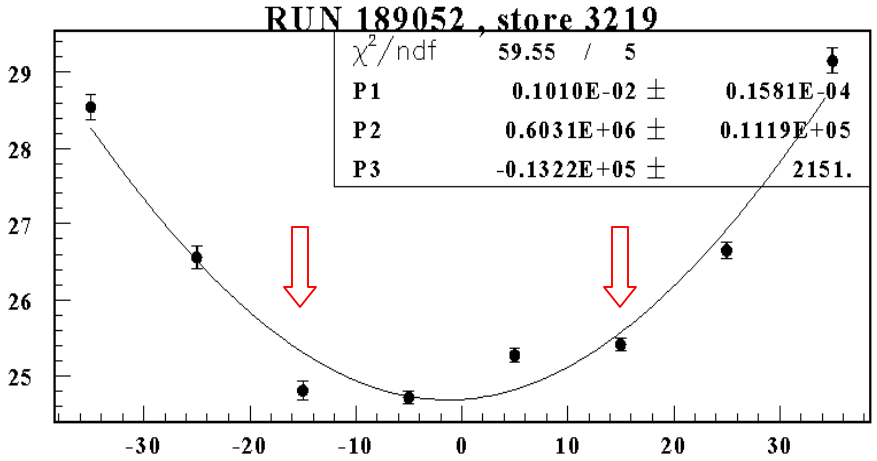
Our data is consistent with something like this.

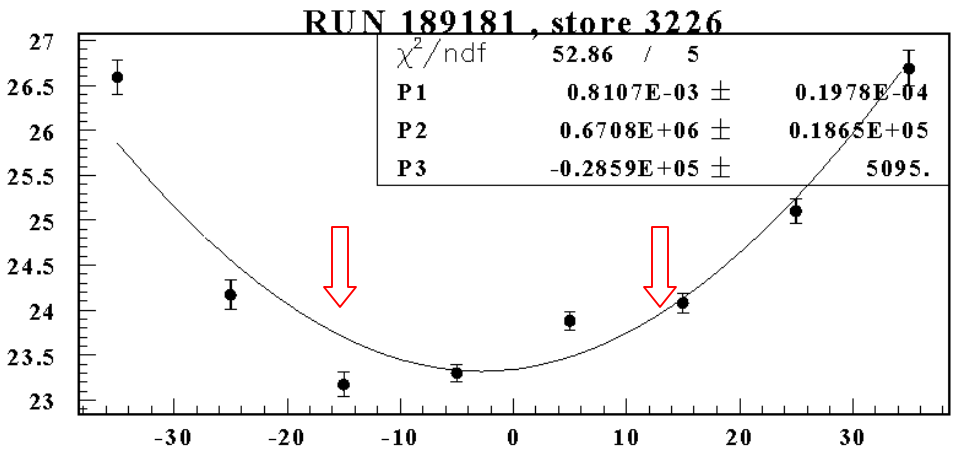
Question to answer:

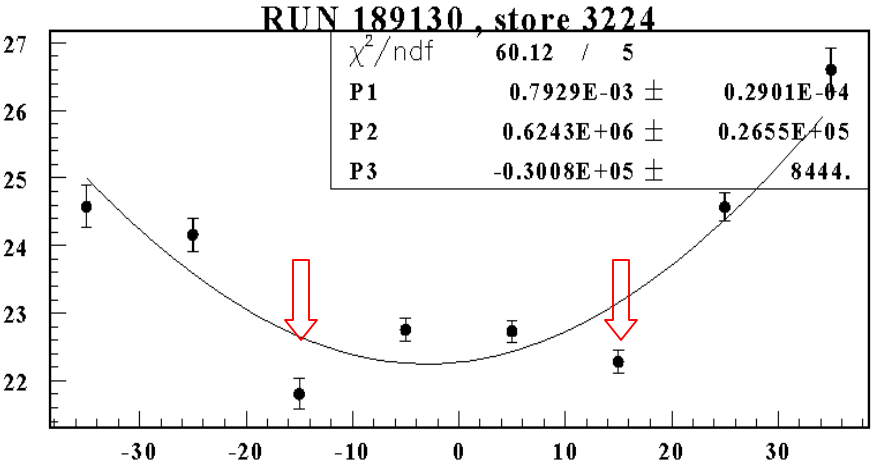
- Is this possible? (Yes, in theory)
- What needs to go wrong to get this problem in the IP?
- Do we have any evidence that tells us that this is not happening?

β* for the luminous region looks larger than for each beam.

More stores

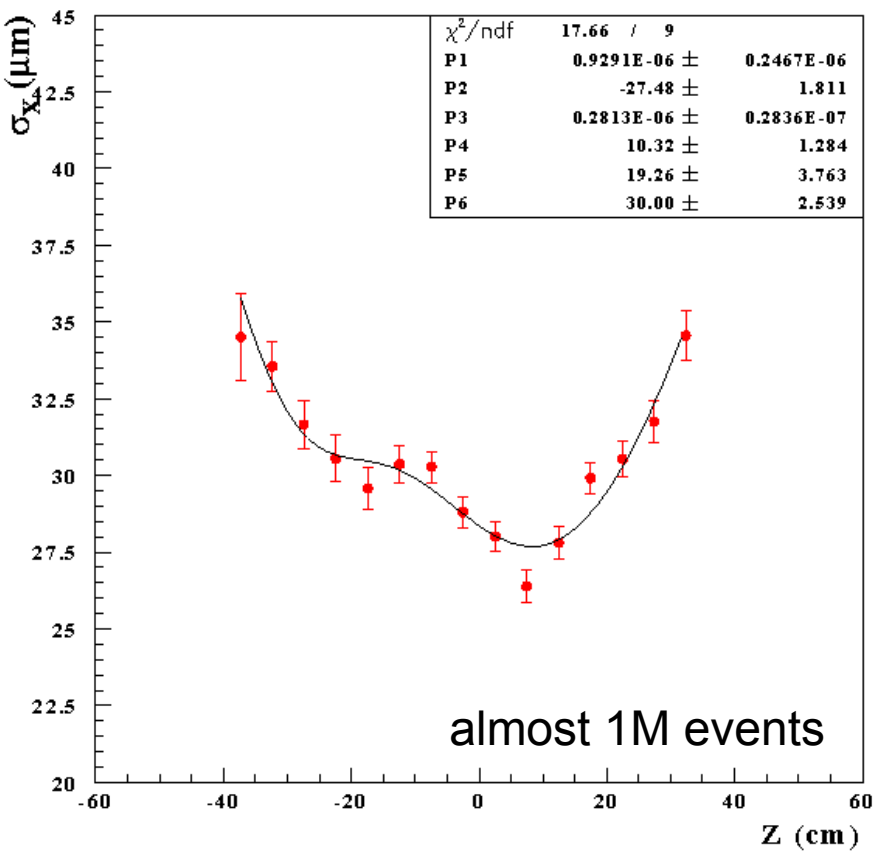


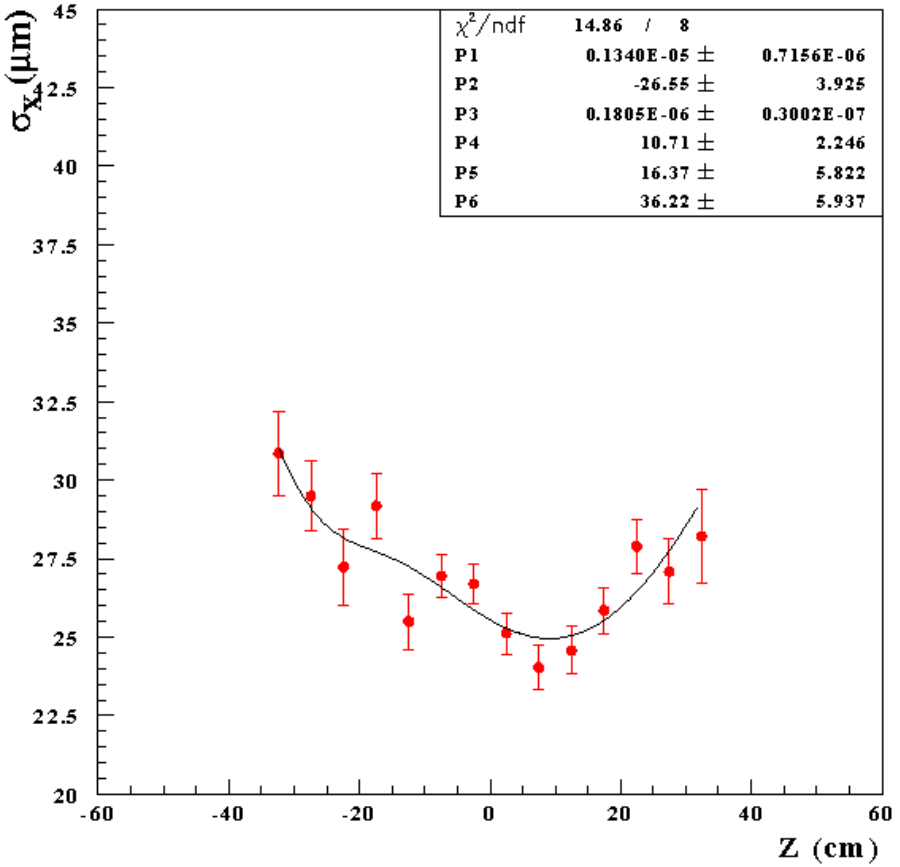




Seems to me like we have 2 waists. Depending on the emittances of each beam, which one dominates.

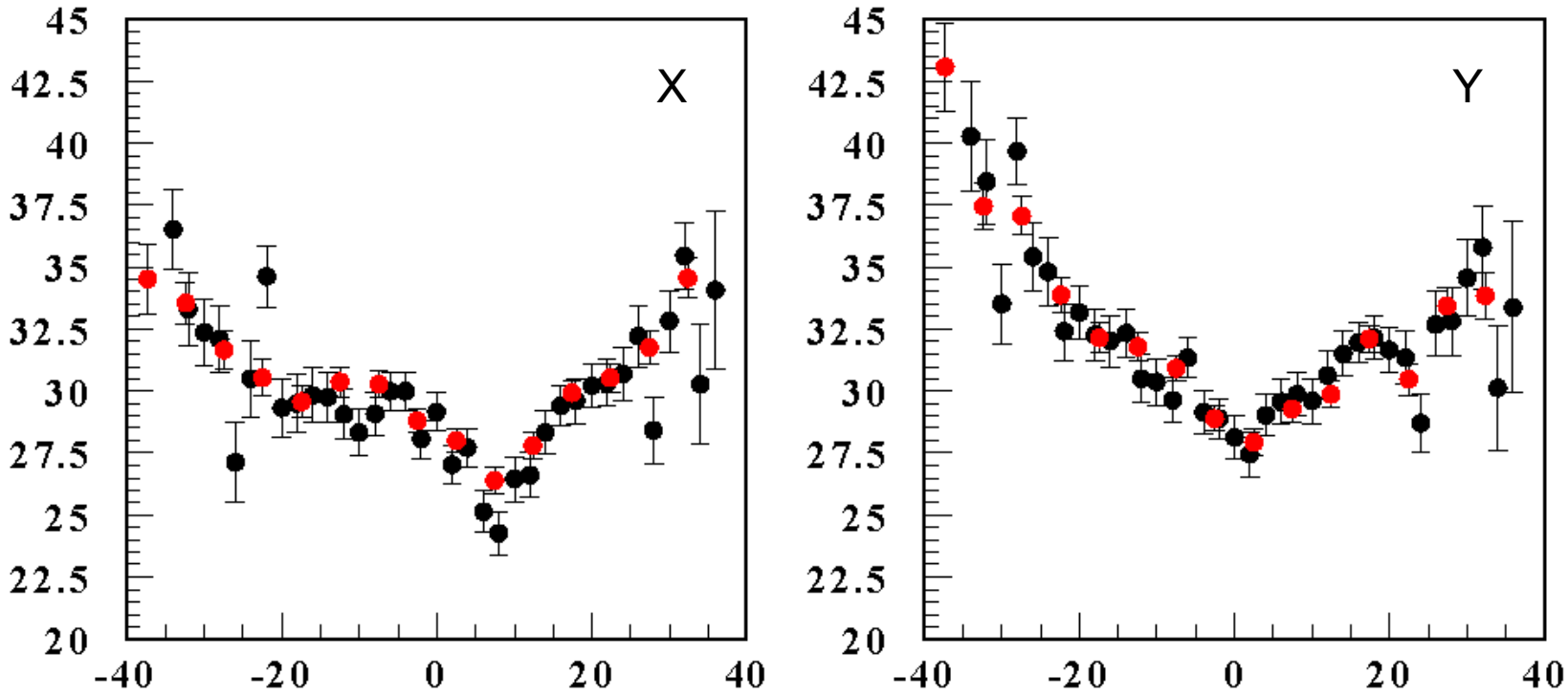
More data





Our data can be fitted with this model, but the β* for each beam would have to be smaller than 35cm…..

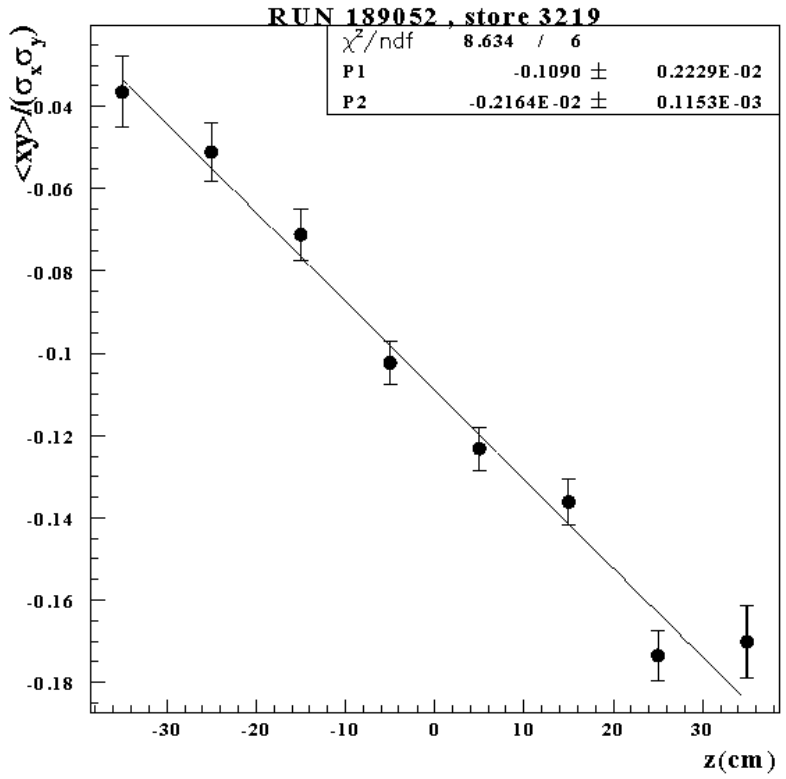
Not an alignment issue

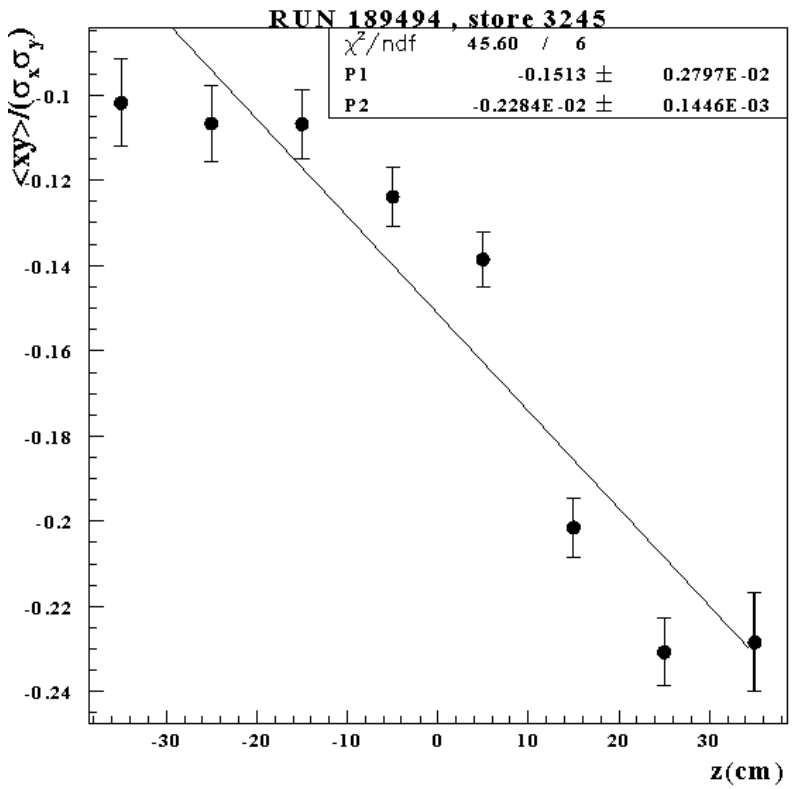


I think an alignment problem can introduce a larger spread in the vertex resolution because the beam does not look straight (not a fixed position inside the Z bin). To see how much this could be affecting our results, I went to bin size of 2 cm (from 10 cm) and see that our result does not change.

Assuming no detector vibration.

X-Y coupling





As requested by the Tevatron department, we are keeping and eye on the coupling. There has been an jump in the coupling recently…

Conclusion

- We still see a very flat luminous region consistent with large β^* in the very model.
- We see some correlation between our beamwidth and the emittance measurements at the Tevatron (but this is not a straight forward thing to do because emittances change during the store and the two Tevatron measurements do not agree).
- Now thinking about the possibility of having 2 waists separated in *Z*. **Still have to work understanding if this could be our problem**… for the moment this is just an idea consistent with our data.

Remember to thank Avdhesh next time you see him.